

# Accelerating Deployment of CCS at U.S. Coal-Based Power Plants

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# A Report on Work in Progress

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*Being conducted for the Pew Center on Global Climate Change, by:*

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# Outline of Talk

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- The need for CCS deployment
- How it might be achieved
- What it would cost
- A CCS Trust Fund approach

# Premise

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- Coal-based power plants will continue to provide the major share of U.S. electricity demand for decades to come, and
- Significant reductions in the CO<sub>2</sub> emissions from such plants are urgently needed as part of a national effort to address global climate change

# Why the Need to Accelerate CCS?

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*Only CCS has promise to enable the United States to:*

- Continuing to rely on coal for a significant portion of electricity generation , while
- Addressing global climate change

# Barriers to CCS Deployment

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- No current requirements to limit CO<sub>2</sub> emissions in U.S.
- CCS not yet demonstrated in full-scale utility applications
- Current CCS is costly (~30-70% increase in COE)
- Limited or no financial incentives for private investment
- Uncertain regulatory and liability issues surrounding geological sequestration

# Deployment is Needed to . . .

- Establish the reliability and true cost of CCS in utility applications at commercial scale, for:
  - Alternative technologies (PC, IGCC; new, retrofit)
  - Different coal types (bituminous, sub-bit, lignite)
  - Different geological settings
- Establish the legal and regulatory requirements for geological sequestration at significant scales
- Reduce future cost of CCS via learning-by-doing plus sustained R&D

# CCS Acceleration Options

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- Cap-and-trade (carbon price) of sufficient stringency
- Low-carbon portfolio standards
- Generator performance standards
- Program to pay for CCS deployment
- Combinations of the above



# Evaluation Criteria

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*Work at the Pew Center is evaluating options based on:*

- Effectiveness in reducing emissions
- Cost and cost-effectiveness
- Familiarity (precedents)
- Equity (regions, firms, technology)
- Ease of implementation
- Timing of implementation
- Linkage to other policies
- Impact on utility coal use

# This Study . . .

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- Focuses on a program to accelerate CCS deployment by paying the incremental costs of installing and operating CCS systems at a number of power plants
- Costs would be borne by a fee on electricity generation. A CCS Trust Fund would be established to select and fund appropriate projects
- Program evaluated at two scales with different (but complementary) objectives

# Smaller-Scale Program

- Objectives

- Establish the true cost and reliability of CCS options
- Obtain design and integrated CCS operating experience
- Develop public and regulatory experience with CCS

- Scope

- ~10 power plants (a selected mix of plant types, coal types, capture technologies, storage sites)
- 5 industrial-sourced storage-only projects
- ~10-year program

# Larger-Scale Program

- Objectives

- All of the preceding, plus
- Significantly reduce CCS costs and generation losses
- Build public confidence in technology and regulatory system
- Reduce U.S. emissions by 100 MtCO<sub>2</sub>/yr by program's end

- Scope

- ~30 power plants
- Multiple “generations” of CCS technologies
- 10 industrial-sourced storage-only projects
- ~15-year program

# Program Elements

- CO<sub>2</sub> Sources
  - Commercial power generation units ( $\geq 400$  MW<sub>net</sub>)
  - Other large industrial sources with high-purity CO<sub>2</sub> vents (e.g., ethanol plants, ammonia and fertilizer plants, natural gas processing plants, coal-to-liquids or -gas plants)
- Incremental costs to be covered:
  - Capital costs to install capture equipment
  - Reimburse loss of net generation capacity
  - Added O&M costs
  - CO<sub>2</sub> transport and injection costs

# What Would It Cost?

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- Plant-level costs will vary depending on technology and site-specific parameters
- Preliminary estimates based on recent studies for two (bounding) cases:
  - CCS added to an existing plant (retrofits)
  - CCS included in original design (new plants)

# Average Cost of CCS (per plant)

(Millions of 2006 U.S. dollars)

Per Plant Incremental Costs to be Covered	Based on Plant Retrofits	Based on New Plants
Capital Costs		
- Capture equipment	\$250	\$210
- Net capacity loss	\$360	\$180
Plant O&M Costs	\$150	\$150
Transport, Storage; Admin.	\$190	\$190
TOTAL	\$950	\$730

*\* Source: Kuuskraa, 2007, Report for the Pew Center on Global Climate Change*

# Estimated Program Costs and Fees

- **10-Plant Program\*:** – \$8-10 billion (total)  
– \$0.0004 to \$0.0005 per kWh\*\*
- **30-Plant Program\*:** – \$23-30 billion (total)  
– \$0.0011 to \$0.0014 per kWh\*\*

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- \*Included additional storage-only projects
  - \*\*Based on current coal-fired generation and 10-yr program
  - Fees likely to decline due to:
    - Increases in future U.S. generation
    - Learning from experience and R&D
  - Fees also would be lower if:
    - Time-frame is extended
    - Plants provide cost-sharing for projects

*Source: Kuuskraa, 2007, Report for the Pew Center on Global Climate Change*



# *Why a Trust Fund?*

# Advantages of a CCS Trust Fund

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- Can raise the large amounts of money needed  
(\$7 – 29 billion for 10-30 plant programs)
- Can precede government mandates —  
deploy CCS options more quickly  
(accelerates learning and significantly reduces later costs)
- Can ensure that funds will benefit payees  
(renders fees more tolerable)

# Examples of U.S. Funds

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- The Highway Trust Fund: created to finance interstate highway system; supported by fuel taxes
- Abandoned Mine Reclamation Fund: administered through U.S. Department of Treasury
- Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Resources: funds managed by consortium of stakeholders under DOE oversight
- Tobacco Master Settlement Agreement: non-tax payments go to, and are dispersed by, a private entity (National Association of Attorneys General)

# Lessons Learned from Past Programs

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- Self-financing is necessary for expensive programs
- Clear objectives must be established. Fees terminate once objectives are reached.
- Avoid annual federal appropriations process (to ensure reliability of funding; impose fees not taxes)
- Use independent or quasi-public entity (private sector contracting and hiring standards obtain)

# Other Design Issues

- Who pays the fee?
  - Only coal-fueled units?
  - Only fossil-fuel based generation?
  - All electricity providers/purchasers?
  - Only units with CO<sub>2</sub> above a specified level or rate?
- Administrative Structure of the Fund
- What mix of projects to support?
  - Technologies (PC, IGCC; pre-, post, oxyfuel)
  - Plant vintages (new, retrofit, repower)
  - Coal types (bituminous, sub-bituminous, lignite)
  - Sequestration sites & type (aquifers, EOR; regional mix)

# Take Home Messages

- CO<sub>2</sub> emissions from U.S. coal-fired power plants will continue to grow in the absence of effective measures to capture and sequester those emissions
- Deployment of CCS technology is needed now to establish (and improve) its cost and effectiveness for power plant applications at both new and existing facilities
- An accelerated program of CCS deployment can yield significant benefits by reducing the future costs of CO<sub>2</sub> controls, while preserving coal as a vital energy source
- A program supported by fees on generation appears to be an affordable and viable method of achieving those goals

*Additional work is in progress*

# Comments Welcomed

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